



# Angstrom Ultra High Vacuum E-beam Deposition System Standard Operating Procedure



These instructions are intended for reference only, and will *not* replace the thorough training required for proper system operation. Contact a clean room staff member with questions or to report a system problem.

Based on the Angstrom SOP, written by Ibrahim Othman and Dr. Jaeun Yu





<p><b>1.</b></p>	<p><b>GENERAL INSTRUCTIONS:</b></p> <ul style="list-style-type: none"> <li>You should not leave the tool unattended while the tool is running.</li> <li>Fill out all the items in the logbook.</li> <li>Inform cleanroom staff with any abnormal performance of the tool and report in Badger as well.</li> </ul>	
<p><b>2.</b></p>	<p><b>BADGER:</b> Enable the tool in badger.</p>	
<p><b>3.</b></p>	<p><b>VERIFY SYSTEM STATUS:</b> The main chamber pressure should be in the range of <math>10^{-9}</math> to <math>10^{-8}</math> Torr.</p> <p>Check the Cryo Temperature on <b>System&gt;Vacuum System&gt;DepChamber</b> or <b>System&gt;Overrides&gt;DepChamber</b>. The Cryo temperature should be below 15K.</p> <p>Check the logbook and read the comments from the previous user.</p>	





The most updated materials information is available on the Badger comment. You can also view the source information on the software: **Main>Load Materials** or **System>Sources**.

#### 4. VENT:

Go to **System>Vacuum System>LoadLock**. Click “Vent”, then click “Start” to initiate the sequence.

Wait until the LoadLock chamber is fully vented.





## 5. SAMPLE LOADING:

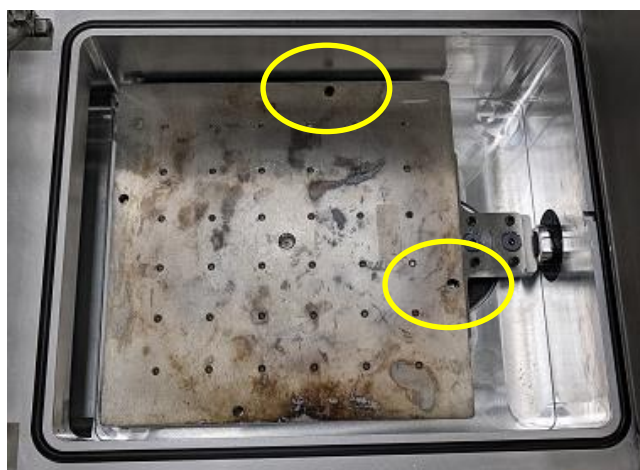
Carefully use the step ladder to open the LoadLock lid. Use the screw knob to lift the plate and rest it upside down on the table.

After clipping of the samples, **you need to make sure that there are no open holes on the plate.**

Also, make sure all the screws with the clips are tight. The loose clips might make the plate loading process difficult as the clips touch the chamber frame or block the holes.

\*The thermal transfer media is available on the workstation. If you have experienced thermal related problems, please use the media. Please talk to clean room staff if you would like to learn more information.

After samples are mounted, put the plate back on the transfer arm in the LoadLock with the two pins matching the holes. **Place two large holes to the back and to the right sides of the LoadLock.**





	<p>Close the LoadLock lid.</p>	
<p><b>6. PUMP LOAD LOCK:</b></p>	<p>Go to <b>System&gt;Vacuum System&gt;LoadLock</b>. Click “Pump Down”, then click “Start” to initiate the sequence.</p> <p>Wait until the LoadLock chamber reaches <u>5E-6 Torr</u>.</p> <p>Note that it will take much longer time to pump down if you add the thermal transfer media.</p> <p>Once the pressure reaches the setpoint, the exclamation mark will disappear.</p>	
<p><b>7. GATE VALVE:</b></p>	<p>When the LoadLock chamber is fully pumped down, go to <b>System&gt;Overrides&gt;LoadLock</b>.</p> <p>Open the GV (gate valve) between the LoadLock and the main deposition chamber.</p>	





## 8. **LOADING THE PLATE:**

Using the positioning knob on the transfer arm, move the transfer arm slowly.

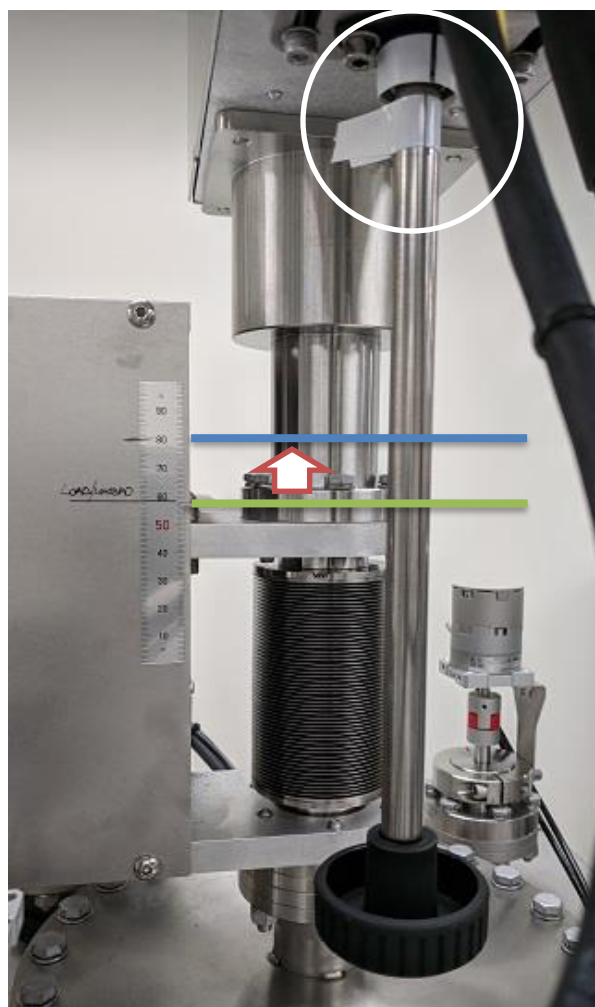
Resistance at the beginning will fade away once the plate passes the wheel that is in the LoadLock.

Check the rotation knob is aligned, and the chamber frame is at the “Load/Unload” position.

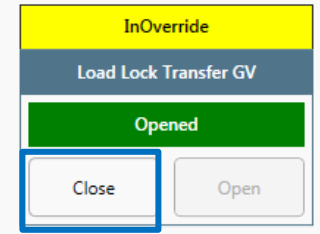
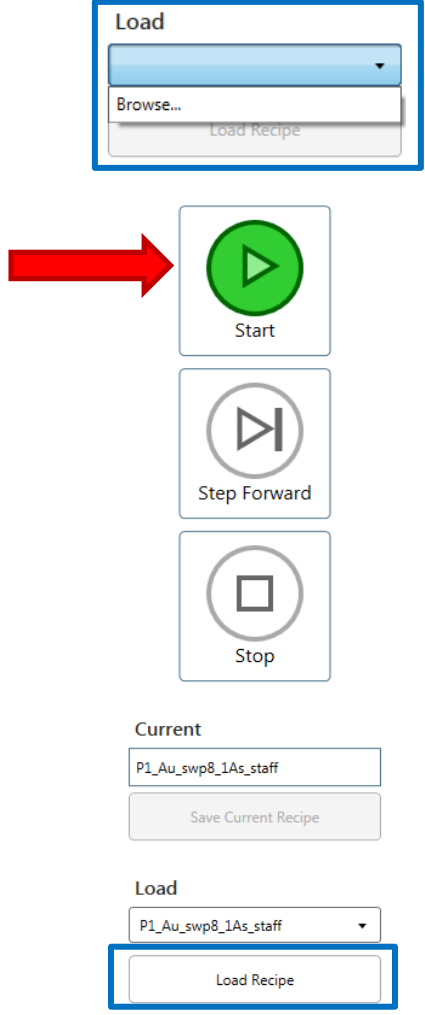
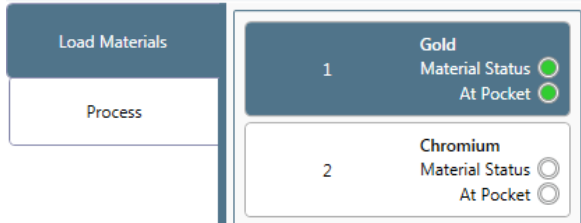
Continue to extend the plate all the way to the front end of the rail. Watch closely from the viewport and be careful with any potential collision.

Now raise the main chamber frame using the leveling button. Watch closely as the pins of the frame approach and pick up the plate. Stop at ~80 (indicated by the black line).

Once the plate completely fits into the main chamber frame, you can see the empty transfer arm under the frame. Bring the transfer arm all the way back to the end of the rail.





	<p>Close the GV between the chamber and LoadLock.</p>													
<p><b>9. CHOOSE A RECIPE AND START DEPOSITION:</b> <u>Users should have their own recipes. Please copy the standard recipes that are available in the Staff folder. Do not edit the standard recipes.</u></p> <p>To learn details of the recipe, please go to <b>steps 18-25</b>.</p> <p>Go to <b>Main&gt;</b>. Click on “Load” to browse your recipe. Then, click “Load Recipe”.</p> <p>Once you load a recipe, the “Start” button will be activated. Click the “Start” button.</p>														
<p><b>10. DEPOSITION-STARTUP:</b> You can check whether the material in the source and the material required by a loaded recipe are matching: Go to <b>Main&gt;Load Materials</b>.</p>		 <table border="1" data-bbox="1079 1659 1412 1858"> <thead> <tr> <th>Step</th> <th>Material</th> <th>Material Status</th> <th>At Pocket</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>Gold</td> <td><input checked="" type="radio"/></td> <td><input checked="" type="radio"/></td> </tr> <tr> <td>2</td> <td>Chromium</td> <td><input type="radio"/></td> <td><input type="radio"/></td> </tr> </tbody> </table>	Step	Material	Material Status	At Pocket	1	Gold	<input checked="" type="radio"/>	<input checked="" type="radio"/>	2	Chromium	<input type="radio"/>	<input type="radio"/>
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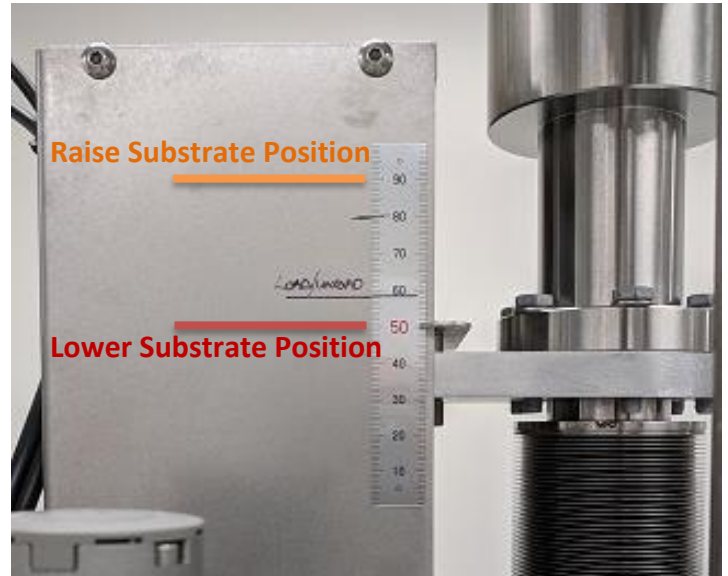




During the “Startup” step, the plate will start rotating and move to the deposition position.

The lower substrate position is the default, and the sensor is only calibrated and accurate at this position.

\*If you choose to deposit at the raise substrate position, you should take into account that the actual film thickness is 85% of the reading thickness.



## 11. DEPOSITION- PRECONDITION:

During the “Precondition” step, you are advised to check the position of the beam spot. If you see the e-beam is off-center, you should stop the deposition and inform the clean room staff.

The “Target Power” should be very close to that of the previous run. You can update the setting parameters during the process. Type the value on the “Edit” column and click “Update”.

	Recipe	Current Setpoint	Edit	
Target Power ( % )	22	17	<input type="text" value="17"/>	<input type="button" value="Update"/>
Ramp Rate ( % / s )	0.3	0.3	<input type="text" value="0.3"/>	
Soak Time ( s )	60	60	<input type="text" value="60"/>	







	<p>Note that once you update the “Target Power” during the step, the “Soak Time” will be reset. If you want to proceed to the next step, simply type a short time (<i>e.g.</i>, 10 s) and click “Update”.</p>																			
<p><b>12. DURING DEPOSITION:</b></p>	<p>If you want to stop the deposition for any reason, you can close the substrate shutter and update the “Target Thickness” to a small value.</p>																			
<p><b>13. POST DEPOSITION:</b></p>	<p>Fill out all the items in the logbook.</p> <p>Record the crystal sensor life after each metal layer. You can find this information in <b>System&gt;Sensors</b>.</p> <p>“Host Sensor (high)” is calibrated for the deposition.</p>	<table border="1"> <thead> <tr> <th>Name</th> <th>Sensor Name</th> <th>Rate</th> <th>Thickness</th> <th>Frequency</th> <th>Remaining</th> </tr> </thead> <tbody> <tr> <td>Physical Sensor 1</td> <td>Host Sensor (High)</td> <td>0.01 A/s</td> <td>-11774.42 A</td> <td>5990279.2 Hz</td> <td>99.514%</td> </tr> <tr> <td>Physical Sensor 2</td> <td>Dopant Sensor (Low)</td> <td>0.15 A/s</td> <td>-7.80 A</td> <td>5542666.0 Hz</td> <td>77.133%</td> </tr> </tbody> </table>	Name	Sensor Name	Rate	Thickness	Frequency	Remaining	Physical Sensor 1	Host Sensor (High)	0.01 A/s	-11774.42 A	5990279.2 Hz	99.514%	Physical Sensor 2	Dopant Sensor (Low)	0.15 A/s	-7.80 A	5542666.0 Hz	77.133%
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<p><b>14. UNLOADING THE PLATE:</b></p>	<p>Go to <b>System&gt;Overrides&gt;LoadLock</b> and open the GV.</p>																			





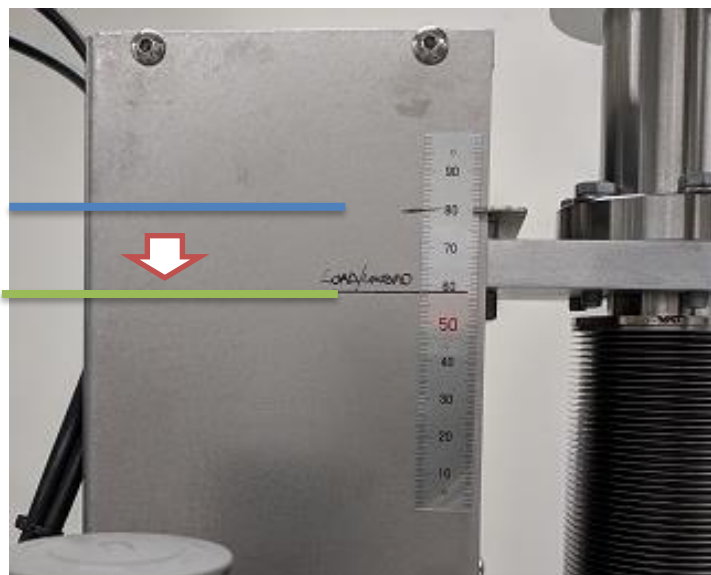
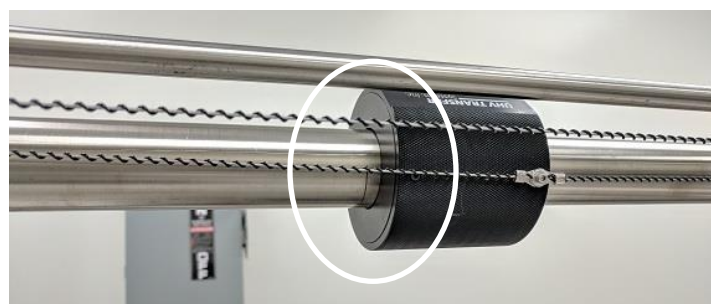
Rotate the chamber frame in alignment with the black mark.

At the lower substrate position, bring the transfer arm until the black line marked on the rail. Do not force. Gently tap on the chamber frame. This step will make the transfer arm and the frame perpendicular to each other. If you deposited at the raised substrate position, you need to move the stage down to the lower position.

Take the transfer arm slightly out and move the stage up to 80 position. Then, bring the transfer arm all the way to the front end of the rail.

Slowly lower the stage to the “Load/Unload” position. Watch closely from the viewport as the plate disengages from the frame. You should not go further down than the “Load/Unload” position. It will bend the transfer arm.

Bring the plate to the LL.





<p><b>15. VENT:</b> Make sure the transfer arm is fully retracted. Close the GV.</p> <p>Go to <b>System&gt;Vacuum System&gt;LoadLock</b>. Click “Vent”, then click “Start” to initiate the sequence.</p> <p>Wait until the LoadLock chamber is fully vented.</p>	
<p><b>16. UNLOAD SAMPLES AND PUMP LOAD LOCK:</b> Unload your samples from the plate. Place all the screws back if you removed any to mount your sample.</p> <p>Put the plate back onto the transfer arm.</p> <p>Close the LoadLock lid, Go to <b>System&gt;Vacuum System&gt;LoadLock</b>. Click “Pump Down”, then click “Start” to initiate the sequence.</p> <p>Wait until the Turbo pump is up to speed.</p>	





<p><b>17. BADGER LOGOUT:</b> Disable the tool in Badger when you're done.</p>	
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## RECIPE SETTINGS:

<p><b>18. OPEN RECIPE:</b> Go to <b>Recipe&gt;</b>. Click on "Open" to load the standard recipe from the Staff folder or your group folder.</p>	
<p><b>19. SOURCES:</b> You can find the material information on the SOURCES tab. Do not change any parameters here.</p>	





<p><b>20. STARTUP:</b></p> <ul style="list-style-type: none"> <li>- Substrate Rotation: You can disable the rotation, if necessary.</li> <li>- IO: “Lower Substrate” is the default position that the host sensor is calibrated at. You can choose “Raise Substrate” position. Note that you have to calculate the target thickness manually.</li> </ul>	
<p><b>21. PRECONDITION:</b></p> <ul style="list-style-type: none"> <li>- Target Power (%): power is increased from 0 to the “Target Power”. Please check the logbook. It should be very close to that of the previous run.</li> <li>- Ramp Rate: Please keep the ramp rate 0.1 %/sec or lower.</li> <li>- Soak Time (s): amount of time to stay at the target power.</li> </ul>	
<p><b>22. STABILIZE:</b></p> <ul style="list-style-type: none"> <li>- Target Rate (Å/s): deposition rate, usually it's set as 1 Å/s.</li> </ul>	





<ul style="list-style-type: none"> <li>- Accuracy Threshold % (+/-): usually set to be 10% range of the setting rate.</li> <li>- Hold Time (s): 10 sec is enough for the hold time.</li> <li>- Timeout (s): the maximum amount of time allowed to reach 10% range of the rate. If failed, the process will be aborted. It's set as 300 sec, <u>except 60 sec for Au in order not to <u>oversoak</u></u>.</li> </ul>	
<p><b>23. DEPOSIT:</b> At “Deposit” step, the substrate shutter will be opened, and the deposition will be started.</p> <ul style="list-style-type: none"> <li>- Target Thickness (Å): the thickness you intend to deposit.</li> <li>- <u>Timeout (s): the maximum amount of time allowed to deposit the target thickness. Click “Calculate +20%”</u>. If you change the target thickness during the deposition, don't forget to update the timeout to a longer time. Otherwise, the process will be aborted.</li> </ul>	





## 24. POSTCONDITION:

- Target Power (%): set to 0.
- Ramp Rate: please keep the ramp rate 1 %/sec or lower.
- Sock Time (s): please keep the soak time 60 sec for Pt and 30 sec for all other materials.

## 25. SAVE:

Click on “Save”. Save your own recipes under your group folder. Do not edit the standard recipes in the Staff folder.

